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Industrial automation systems and integration — Integration of industrial data for exchange, access, and sharing — Part 2: Integration and mapping methodology

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ABSTRACT:

This document defines the integration process for the ISO 18876 architecture for the integration of industrial data.

KEYWORDS:

industrial data, integration, exchange, access, sharing, architecture, overview

COMMENTS TO READER:

This is the fifth working draft of Part 2 of ISO 18876, incorporating changes resulting from review and discussion at the WG10 meeting in London (January 2001). This draft is intended for further review by WG10. Editor's notes are included as boxed text; these include open issues as well as outline descriptions of the clauses/annexes whose detailed content has yet to be created.

Reviewers are encouraged to submit and discuss issues via the ISO 18876 list that has been established at egroups – see <http://www.iso18876.org> for details.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this part of ISO 18876 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 18876-2 was prepared by Technical Committee ISO/TC184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

This International Standard is organized as a series of parts, each published separately. The structure of this International Standard is described in ISO 18876-1.

A complete list of parts of ISO 18876 is available from the Internet:

[<http://www.iso18876.org/parts.html>](http://www.iso18876.org/parts.html)

Annex A forms a normative part of this part of ISO 18876. Annexes B, C, D, and E are provided for information only.

0 Introduction

0.1 Overview of ISO 18876

This International Standard establishes an architecture, a methodology, and other specifications for the integration of industrial data for exchange, access, and sharing. The following activities are supported:

- integrating data which may be from different sources or different contexts, which may be described by different models, which may be written in different modelling languages;
- sharing data among applications through systems integration architectures;
- resolving conflict between models developed with different objectives;
- translating data between different encodings;
- translating models between different modelling languages.

The components that support these activities include:

- integration models;
- methods for creating, extending, and updating integration models;
- methods for creating a mapping specification to map data instances between an integration model and an application model that falls within its scope;
- encoding and decoding of data and models with different formats, such as ISO 8876 (SGML), XML, ISO 10303-11 (EXPRESS), ISO/IEC 19501-1 (UML) and ISO 10303-21;
- methods for consolidating data sets from different sources and different models ;
- appropriate modelling and mapping languages.

ISO 18876-1 provides an overview of the architecture and methodology of this International Standard.

0.2 Organization of this part of ISO 18876

The organization of this part of ISO 18876 is as follows:

- clause 1 specifies the scope and field of application of this part of ISO 18876;
- clause 2 identifies additional standards that, through references in this part of ISO 18876, constitute provisions of this part of ISO 18876;
- clause 3 defines terms used in this part of ISO 18876;
- clause 4 describes a number of usage scenarios for the application of the methods defined in this part of ISO 18876;
- clause 5 specifies the methods for integrating application models, and is supported by a detailed activity model presented in Annex B;
- clause 6 specifies the criteria that apply to integration models and mappings that conform to the provisions of this part of ISO 18876.

The methods specified in clause 5 are independent of modelling languages, mapping languages, and particular integration models. Annex C provides guidelines for the application of the methods specified in clause 5 to models that are defined in EXPRESS (ISO 10303-11) and mappings that are defined in EXPRESS-X (ISO 10303-14).

0.3 Target Audiences

The target audience for this document is modellers, analysts, systems integrators, and systems developers with a need to integrate application models across a range of systems and/or enterprise functions. The target audience for the Introduction to this document is technical managers responsible for integration projects with a need to assess the applicability of this standard.

0.4 Conventions

This part of ISO 18876 includes provisions that indicate requirements strictly to be followed in order to conform to the standard. Such provisions are indicated through the use of the words “shall” and “shall not”. This part of ISO18876 also includes provisions that indicate that among several possibilities one is recommended as particularly suitable. Such provisions are indicated through the use of the words “should” and “should not”. Additional material that illustrates the provisions of this part of ISO 18876 is presented in the form of notes, examples, and in the informative annexes B, C, and D.

Industrial automation systems and integration — Integration of industrial data for exchange, access, and sharing — Part 2: Integration and mapping methodology

1 Scope

This International Standard establishes an architecture, a methodology, and other specifications for the integration of industrial data for exchange, access, and sharing. The following activities are supported:

- integrating data which may be from different sources or different contexts, which may be described by different models, which may be written in different modelling languages;
- sharing data among applications through systems integration architectures;
- resolving conflict between models developed with different objectives;
- translating data between different encodings;
- translating models between different modelling languages.

This part of ISO 18876 specifies methods for the following:

- creation and extension of integration models;
- evaluation and selection of an integration model that can integrate two or more application models;
- creation of an application model that is a constrained subset of an integration model to support particular application domain requirements for exchange and/or sharing;
- creation of a mapping specification between an application model and an integration model.

The following are within the scope of this part of ISO 18876:

- modelling language independent methods for creating and extending an integration model;
- methods for integrating an application model with an integration model;
- mapping language independent methods for mapping an application model to an integration model;
- criteria for the selection of modelling languages and mapping languages that can be used within the specified methods for integration and mapping;
- guidelines for creating and extending integration models that are defined in the EXPRESS language (ISO 10303-11);
- guidelines for mapping between application models and integration models where both are defined in the EXPRESS language and the mapping is represented in the EXPRESS-X language (ISO 10303-14).

The following are outside the scope of this part of ISO 18876:

- the structure and content of particular integration models;
- methods for creating and extending particular integration models;
- methods for mapping application models to particular integration models.

NOTE The specific methods that apply to mappings between particular application models and integration models depend on the modelling paradigm(s) applied and on the structure and content of the models.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 18876. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 8824-1:1994, *Information technology — Open systems interconnection — Abstract syntax notation one (ASN.1) — Part 1: Specification of basic notation*.

ISO 10303-1:—¹⁾, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*.

ISO 10303-11:—²⁾, *Industrial automation systems and integration — Product data representation and exchange — Part 11: The EXPRESS language reference manual*.

ISO 10303-14:—³⁾, *Industrial automation systems and integration — Product data representation and exchange — Part 14: The EXPRESS-X language reference manual*.

ISO 18876-1:—³⁾, *Industrial automation systems and integration — Integration of industrial data for exchange, access, and sharing — Part 1: Architecture overview and description*.

Others to be added as required – I've assumed here that we will want to reference the second editions of Part 1 and Part 11 of STEP.

3 Terms, definitions, and abbreviations

For the purposes of this part of ISO 18876, the following terms, definitions and abbreviations apply; those taken or adapted from ISO 10303-1 and ISO 18876-1 are repeated below for convenience.

NOTE 1 Definitions copied verbatim from other standards are followed by a reference to the standard in brackets, such as “[ISO 10303-1]”. In these cases the definition in the referenced document is normative; its repetition here is informative and in the case of any discrepancy the definition in the referenced document has precedence. An explanatory note follows definitions that have been adapted from other standards. In these cases the definition given here is normative for the purposes of this part of ISO 18876.

¹⁾ To be published. (Revision of ISO 10303-1:1994)

²⁾ To be published. (Revision of ISO 10303-11:1994)

³⁾ To be published.

NOTE 2 A glossary of terms and definitions used in this International Standard is available on the Internet:

[<http://www.iso18876.org/glossary.html>](http://www.iso18876.org/glossary.html)

3.1

application model (AM)

model that represents information used for some particular purpose

NOTE Some application models are also integration models (see 3.13).

[ISO 18876-1]

3.2

class

collection to which some significance is attached

EXAMPLE Pump, power station, engineer, and fictional space vehicle are examples of classes.

[ISO 18876-1]

3.3

concept

general notion or abstract idea

[ISO 18876-1]

3.4

construct

structure of data together with its intended meaning

3.5

data

representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers

[ISO 10303-1]

3.6

data model

definition, structure, and data types for data

[ISO 18876-1]

3.7

derived concept

concept in an integration model that is wholly defined in terms of primitive concepts

[ISO 18876-1]

3.8

foundation concept

primitive concept that determines the underlying world viewpoint of an integration model

EXAMPLE The concepts of “class” and “individual” are foundation concepts for a general integration model.

[ISO 18876-1]

3.9

general concept

primitive concept that is has very wide applicability, but is a specialization of some foundation concept

NOTE The boundary between a foundation concept and a general concept may be arbitrary; some concepts may be thought of as both foundation concepts and general concepts.

[ISO 18876-1]

3.10

individual

thing that exists in space and time

NOTE This includes things that actually exist, or have existed, and things that possibly exist in the past, present or future.

EXAMPLE The pump with serial number ABC123, Battersea Power Station, Sir Joseph Whitworth, and the Starship “Enterprise” are examples of individuals.

3.11

information

facts, concepts, or instructions

[ISO 10303-1]

3.12

integration

activity that creates, modifies, or extends an integration model

[ISO 18876-1]

3.13

integration model (IM)

application model that can represent the information that is represented by two or more application models

[ISO 18876-1]

3.14

mapping

association of a set of elements of a model with a set of elements of another model

NOTE 1 A mapping can be uni-directional or bi-directional.

NOTE 2 A mapping is the result of apply a mapping specification to particular models.

[ISO 18876-1]

3.15

mapping specification

definition of the transformations that relate elements of one model with elements of another model

NOTE 1 A mapping specification can include data structure transformations, data value transformations, data encoding transformations, and terminology transformations.

NOTE 2 Mapping specifications can be procedural, or declarative, or a combination of these.

[ISO 18876-1]

3.16**model**

limited representation of something suitable for some purpose

[ISO 18876-1]

NOTE A model can be data, or a data model, or a combination of these. See Annex D for further discussion of the relationship between models, data, and data models.

3.17**model context**

range of activities and viewpoints for which an application model is valid

NOTE This term is more general than application context as defined in ISO 10303-1.

[ISO 18876-1]

3.18**model scope**

range of information that an application model can describe

[ISO 18876-1]

3.19**primitive concept**

concept in an integration model that is not wholly defined in terms of other concepts

[ISO 18876-1]

3.20**specific concept**

primitive concept that is a specialization of some general concept and has a limited range of applicability

EXAMPLE Car, process plant, quark, purchase order, and XML document are examples of specific concepts.

NOTE The boundary between a general concept and a specific concept may be arbitrary; some concepts may be thought of as both general concepts and specific concepts.

[ISO 18876-1]

4 Usage scenarios

The methodology defined in this part of ISO 18876 is designed to meet requirements typified by the following usage scenarios:

- integrating two or more existing application models (see 4.1);
- integrating one or more existing application models with an existing integration model (see 4.2);
- defining an application model and its mapping to an integration model (see 4.3);
- integrating an application model with more than one integration model (see 4.4);
- improving an integration model (—).

4.1 Integrating application models

This component of the methodology integrates two or more application models by creating an integration model that is capable of representing all of the concepts and constraints of the application models. Such an integration model supports the communication of data between applications and users that operate using the application models.

This requirement and its solution are illustrated in Figure 1 below.

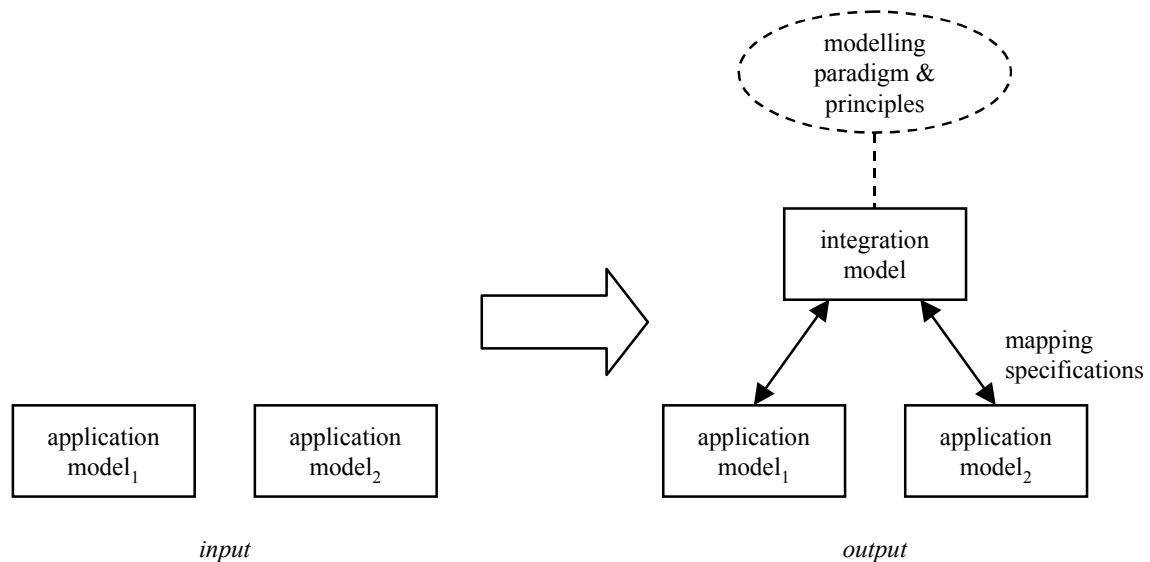


Figure 1 – Creating an integration model that integrates two application models

The inputs to the activity are as follows:

- two or more application models;
- the modelling paradigm and principles chosen for the creation of integration models.

NOTE The use of such principles is an important criterion in determining the future extensibility and reuse of an integration model.

The outputs of this activity are as follows:

- an integration model that represents the concepts and constraints of the input application models;
- mapping specifications that represent the relationships between constructs of each application model and their corresponding subsets of the integration model.

The mapping specifications include any constraints that apply for the application models. The subset of the integration model that corresponds to each application model includes concepts that are not explicit in the application model and have been discovered during the integration process.

4.2 Integrating application models with an integration model

This component of the methodology integrates one or more application models and an existing integration model. The purpose of this activity may be either or both of the following:

- integrating the application models;

- improving the quality of the application models by representing their concepts and constraints in a more consistent and extensible form and structure.

The nature and results of this activity depend on the nature of the integration model and the other application models that are to be integrated. This clause describes the scenario in which the context of the application models to be integrated is covered by the context of the integration model.

NOTE See — for a description of the scenario in which the context of the application models to be integrated is not covered by the context of the integration model.

This requirement and its solution are illustrated in Figure 2 below;

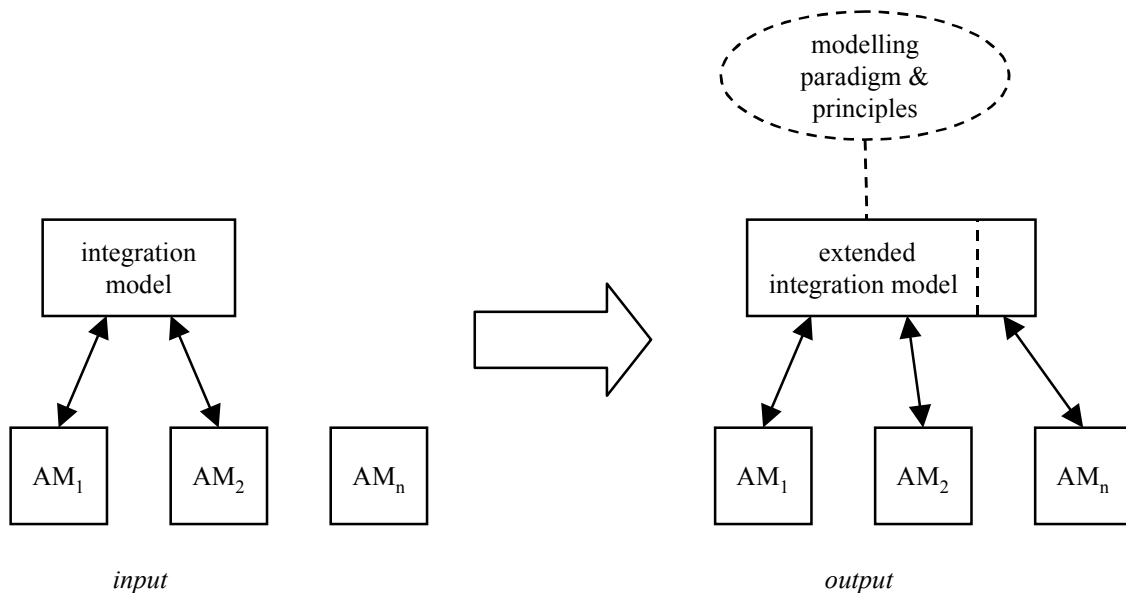


Figure 2 – Integrating an application model with an existing integration model

The inputs to the activity are as follows:

- an existing integration model;
- one or more application models that are integrated with the integration model, including the mapping specifications that relate each application model to its corresponding subset of the integration model;
- the modelling paradigm and principles used to create the integration model – these also determine how the integration model is extended to meet the requirements of the application model.

The outputs of the activity are as follows:

- an extended integration model (if the input integration model does not precisely satisfy the requirements of the application models);

NOTE 2 Extensions to an integration model do not make any change to the input integration model. The scope of the integration model is increased; its context is not changed.

- a mapping specification that represents the relationships between constructs of the application models and the corresponding subsets of the extended integration model;
- improvements to the application model (if appropriate).

4.3 Defining an application model and its mapping to an integration model

This component of the methodology creates an application model together with its mapping to an integration model. The purpose of this activity is to enable use of the integration model in order to achieve integration amongst applications or a community of users that have common information requirements.

This requirement and its solution are illustrated in Figure 3 below.

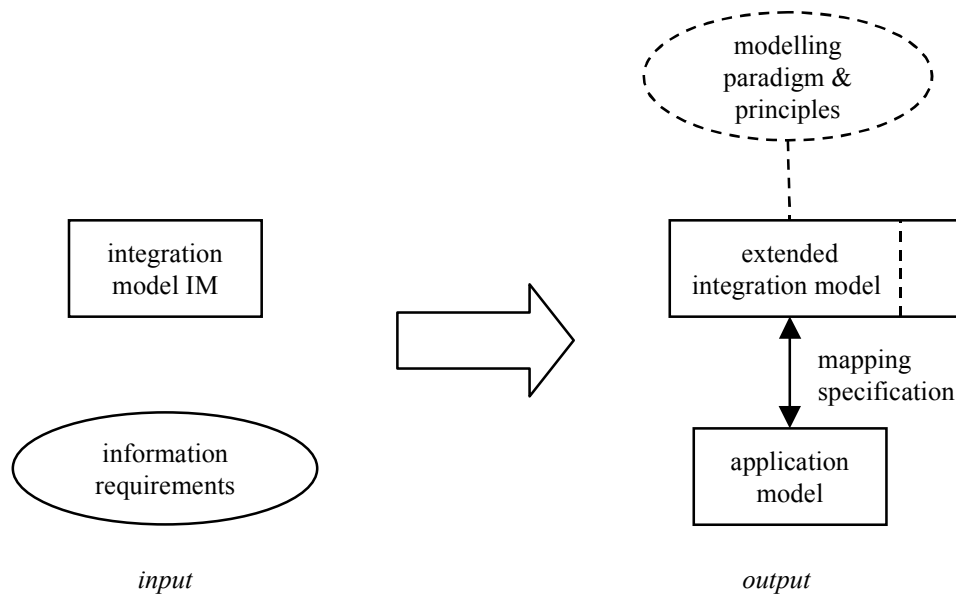


Figure 3 – Creating an application model and its mapping to an integration model

The inputs to the activity are as follows:

- information requirements which may be described by one or more of the following:
 - existing data;
 - existing data models;
 - usage scenarios;
 - paper documents and forms;
 - results of interviews with users;
 - existing applications.
- an existing integration model;
- the modelling paradigm and principles used to create the integration model – these also determine how the integration model is extended to meet the stated information requirements.

The outputs of the activity are as follows:

- an extended integration model (if the input integration model does not precisely satisfy the stated information requirements);

- an application model that satisfies the stated information requirements and is mapped to the integration model;

NOTE The application model may use the structure and/or the terminology of the integration model. If it uses both, then it is identical to a subset of the integration model and the mapping between them is trivial.

- a mapping specification that represents the relationships between constructs of the application model and the corresponding subset of the extended integration model.

4.4 Integrating an application model with two or more integration models

An application model need not be integrated with only one integration model. As shown in Figure 4 below an application model can be integrated with two or more different integration models.

The inputs to this activity are as follows:

- one or more application models;
- two or more integration models with which the application models are to be integrated;
- the modelling paradigm and principles used to create the integration models.

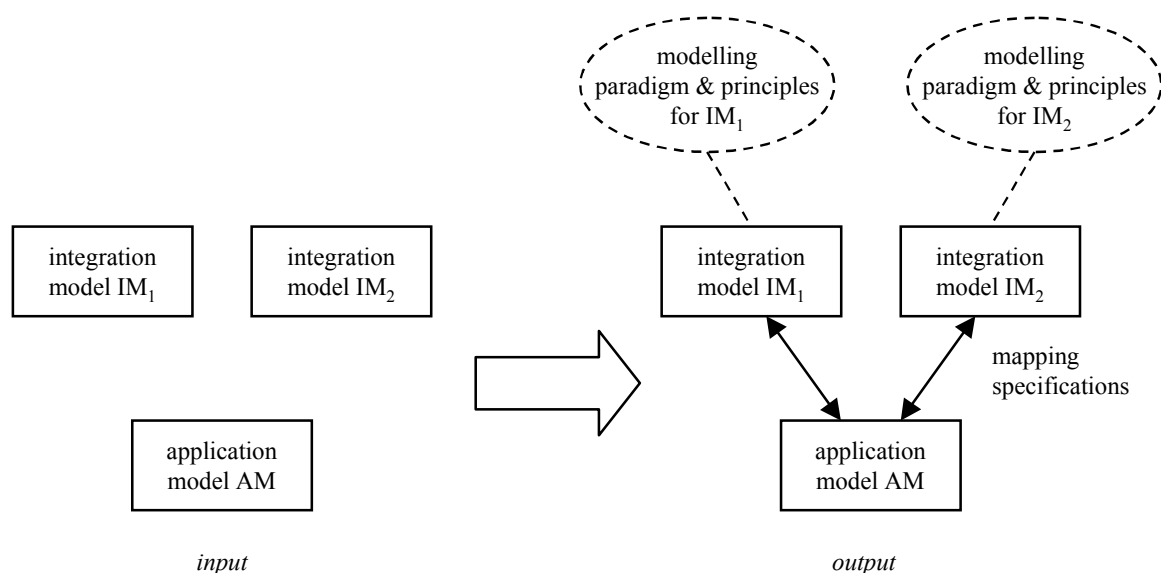


Figure 4 – Integrating an application model with more than one integration model

For an application model to be integrated with two or more integration models, the following conditions shall be satisfied:

- the context of the application model must be covered by the context of each integration model;
- the scope of the application model must be covered by the scope of each integration model, which may be extended to meet this requirement.

Integration with each integration model depends on the modelling principles and paradigm that apply to the development and extension of that integration model.

The outputs of the activity are as follows:

- extended integration models (if one or more of the input integration models do not precisely satisfy the requirements of the application model);
- mapping specifications that represent the relationships between constructs of the application model and the corresponding subsets of the each of the integration models;
- improvements to the application model (if appropriate).

4.5 Improving an integration model

This aspect of the methodology creates a new integration model in the case that an existing integration model does not satisfy the requirements of an application model, and cannot be extended to do so. This situation arises when the context of the integration model is insufficiently broad to meet the needs of the application models that are to be integrated. This insufficiency may be observed as constraints in the structure of the integration model that do not apply for one or more application models that are to be integrated.

This requirement and its solution are illustrated in Figure 5 below.

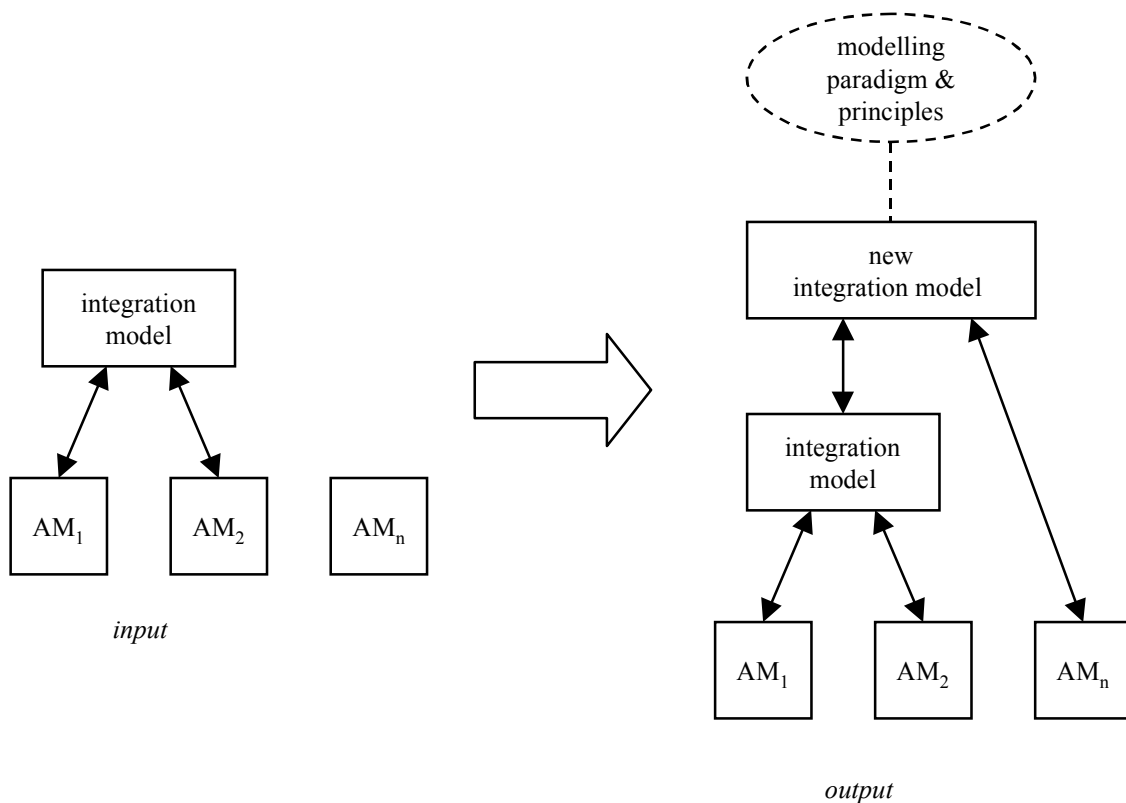


Figure 5 – Improving an integration model

The inputs to this activity are as follows:

- an existing integration model;
- one or more application models that are integrated with the integration model, including the mapping specifications that relate each application model to its corresponding subset of the integration model;
- one or more further application models that are to be integrated but whose requirements cannot be satisfied using the existing integration model.

The outputs of the activity are as follows:

- a new integration model that has a broader context than that of the original integration model;

NOTE 1 This new integration model may have to be developed on the basis of a more general modelling paradigm than that used for the original integration model.

EXAMPLE An integration model that uses associations to represent and manage change may not be capable of integrating all application models of interest. A change of modelling paradigm is required to develop an integration model that can satisfy a wider set of requirements. An integration model based on spatio-temporal extents can represent and manage change for a wider range of application models than one based on associations.

- a mapping specification that represents the relationships between constructs of the original integration model and the corresponding subset of the new integration model;
- mapping specifications that represent the relationships between constructs of each application model and their corresponding subsets of the new integration model.

The scenario depicted in Figure 5 results in the creation of a mapping specification from the initial integration model to the new integration model. This implies that in order to migrate data from application model AM_1 to application model AM_n it is necessary to consider three mappings: that from AM_1 to the original integration model, that from the original integration model to the new integration model, and that from AM_n to the new integration model. Technical or economic considerations may result in an alternative approach, as shown in Figure 6 below. Here mapping specifications are defined between the initial integrated application models AM_1 and AM_2 and the new integration model. This reduces the number of mapping specifications to be considered for pairwise combinations of application models, at the expense of additional analysis and mapping effort.

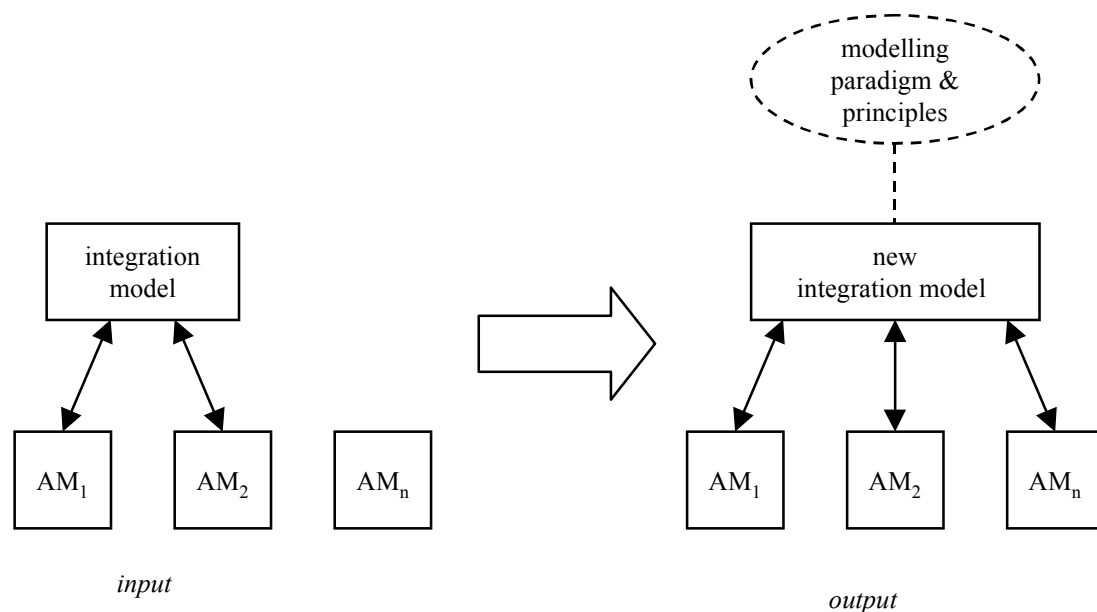


Figure 6 – Alternative mappings to an improved integration model

5 Methods for integrating application models

This clause presents the methods that shall be applied in order to integrate application models. These are divided into four stages:

- analysis of the application model and other information requirements;

- extension of the integration model (if required);
- identification of the subset of the integration model that corresponds to the application model;
- definition of a mapping between the application model and the identified subset of the integration model.

Each stage is characterized by the necessary preconditions, a description of the methods to be applied, and the post conditions that determine the successful application of the methods.

NOTE An activity model for the integration process is shown in Annex B.

5.1 Analysis of the requirements

The purpose of this activity is to identify an integration model that is suitable for integrating the application model(s) of interest, and to determine how the concepts that are represented by the application model(s) are related to the concepts of the chosen integration model.

5.1.1 Preconditions

5.1.1.1 Application model

The following preconditions apply to analysis of application models:

- definitions, diagrams, and other specifications that describe the application model shall be available;
- example data populations that illustrate usage of the application model shall be available;
- application domain experts shall be available to provide information about the use of the model in different implementations.

NOTE Additional information supplied by application domain experts is often needed to fully understand the context of the application model and to ensure that this implicit information is explicitly represented in the integration model or in the application model's mapping specification.

5.1.1.2 Modelling languages

No specific preconditions apply to the modelling languages used to describe application models. The documentation that describes an application model should state any assumptions, usage practices, or other supporting information that characterizes the way in which a modelling language represents the model.

NOTE 1 Although desirable, this information may not be available for some application models. Analysts should therefore be familiar with different usage practices for modelling languages.

NOTE 2 In the absence of explicit documentation of the usage practices applied, analysts should not assume that a modelling language has been applied consistently within the description of an application model.

5.1.2 Method description

The methods that apply to analysis of requirements are as follows:

- selection of an integration model;
- analysis of application model concepts.

5.1.2.1 Selection of an integration model

Although creation of an integration model that solely integrates two or more integration models is possible (see 4.1) a more common requirement is to integrate one or more application models with an existing integration model (see 4.2). The following criteria apply to the selection of a suitable integration model.

- The integration model chosen shall have a model context that includes the model context of the application model(s) being integrated.

NOTE 1 If the model context of an application model is not wholly contained in the model context of an integration model, then the integration model cannot integrate all the concepts represented in the application model(s) without change to the integration model.

NOTE 2 Analysis of activity models is good practice for determining the overlap between the model context of an application model and the model context of an integration model.

- If more than one integration model is available with a suitable model context, the integration model chosen should have a model scope that is closest to or overlaps with that of the application model(s) to be integrated.

NOTE 3 Choice of an integration model whose scope overlaps with that of the application model(s) to be integrated is likely to simplify the integration process and to reduce the need for extension of the integration model.

NOTE 4 Analysis of application models that have already been integrated with a candidate integration model, and their associated mapping specifications, is good practice for determining overlaps of scope. Similarly, analysis of the derived concepts that are explicitly represented in an integration model is good practice for determining overlaps of scope.

5.1.2.2 Analysis of application model concepts

This analysis is illustrated in Figure 7 below.

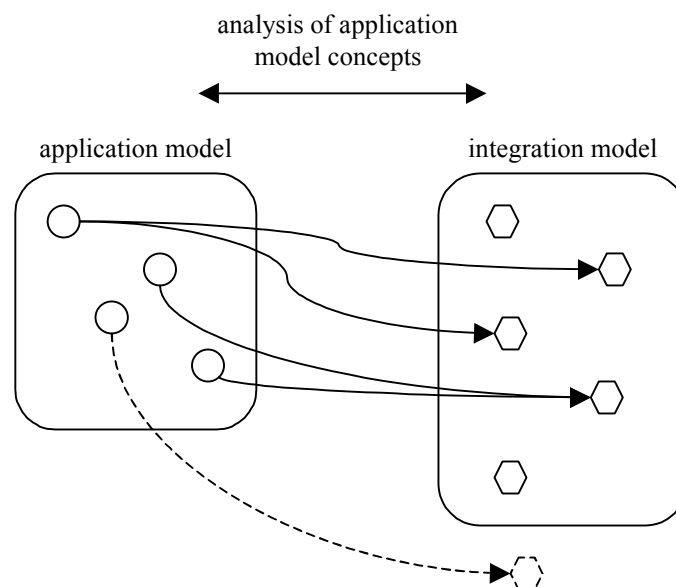


Figure 7 – Analysis of application model

The nature of these relationships varies considerably, depending on the nature of the models involved. Some or all of the following relationship types may be recognized during this analysis:

- equivalence: the same concept exists in the application model and the integration model, and has the same name in both cases;
- synonyms: the same concept exists in the application model(s) and the integration model, but one or more of the model uses a different name for the concept;
- homonyms: concepts exist within one or more of the application model(s) and the integration model that have the same name but have different meanings;
- complex concepts (in the application model): a single concept in the application model corresponds to more than one concept in the integration model;

EXAMPLE 1 An application model includes the concept “red car” and is mapped to an integration model that represents as separate concepts “red (thing)” and “car”. The application model concept is represented by a combination of the two integration model concepts.

EXAMPLE 2 An application model includes an entity data type called **product** which can represent either individual manufactured items (identified by serial numbers) or classes of manufactured items (identified by part numbers). If these are recognized as separate concepts in the integration model as **physical_object** and **class_of_physical_object**, then instances of **product** in the application model can correspond to instances of both concepts in the integration model.

- partitioned concepts (in the application model): two or more concepts in the application model correspond to a single general concept in the integration model.

EXAMPLE 3 An application model contains entity data types called **customer** and **supplier**. These may both correspond to a general entity data type in the integration model called **organization**.

Lastly, it is possible that a concept within the application model has no equivalent within the integration model. In this case it is necessary to develop extensions to the integration model so that a subset of the integration model with precise semantic equivalence to the application model can be identified.

5.1.3 Post conditions

The output of the analysis activity is documentation of the semantic relationships that have been discovered between the concepts of the application model and the integration model, together with identification of any voids that have been discovered in the integration model.

5.2 Defining and extending the integration model

If the analysis activity described in 5.1 discovers that one or more of the concepts represented in the application model have no precise equivalent in the integration model, the latter shall be extended before the subsetting and mapping activities can be completed.

NOTE The diagrams in this clause depict only one application model and its relationship to an integration model. This is done for reasons of clarity only; it is assumed that the integration model exists and already integrates two or more other application models.

5.2.1 Preconditions

5.2.1.1 Integration model characteristics

Integration models that have a wide model context and are therefore suitable for integrating many different application models have the following characteristics.

- Each object is modelled in terms of its underlying nature, based on a specific paradigm or view of the world being modelled. This means that each object is not modelled in terms of the role or roles that it plays in particular circumstances nor the information about the object that is of interest in particular cases.

- The names chosen for the model constructs also reflect the underlying nature of the subject of the model.
- Only those constraints that are applicable for the whole content and scope of the model are represented in the structure of the model.
- Classes are represented as nodes in a subclass/superclass (specialization/generalization) hierarchy which is rooted in a single class.
- The model represents and manages history and change.
- Artificial identifiers are used as a surrogate for the identity of the things represented by the model. These identifiers allow assertions of equivalence to be made across multiple files, databases, and other information systems. Other attributes and relationships are not used as parts of these identifiers.
- The modelling language chosen to represent the integration model is used consistently.

NOTE See Annex C for guidelines for the use of the EXPRESS language (ISO 10303-11) to represent integration models.

The following assumptions apply to the use of integration models in the integration process.

- An integration model is not changed by the integration process.

NOTE Change here means alteration to the existing structure or content of the integration model, and is distinguished from the process of extension which adds new constructs to an integration model without altering those that form the integration model at the start of the integration process. If it is necessary to change, rather than extend, the integration model, a new integration model is created.

The following preconditions apply to a selected integration model.

- definitions, diagrams, and other specifications that describe the integration model shall be available;
- all application models that have been integrated with the integration model, and their associated mapping specifications, shall be available;
- the analysts undertaking the integration shall be familiar with the integration model and with its use to integrate application models.
- computer tools that represent the integration model and support creation of mapping specifications should be available.

5.2.1.2 Modelling languages

The modelling language used to specify an integration model shall be capable of representing models with the characteristics specified in 5.2.1.1. In addition, the following requirements on modelling languages apply.

- The modelling language shall have capabilities to represent both classes and instances within a single model.

NOTE The EXPRESS language (ISO 10303-11) primarily represents classes (as entity data types). Integration models that are defined using the EXPRESS language therefore need to use a complementary specification to represent instances, such as encoding mechanisms (ISO 10303-21, ISO 10303-28), instance representations (ISO 10303-12), or EXPRESS constants. See Annex C for guidelines for the use of EXPRESS.

- The modelling language shall completely support the modelling principles and paradigm used for the integration model.

EXAMPLE If the integration model includes the concept of classes being members of other classes, the modelling language should include a capability to represent this relationship between the constructs that represent classes.

- The modelling language shall include capabilities to define mapping specifications, or shall have a companion mapping language

5.2.2 Method description

This activity is illustrated in Figure 8 below.

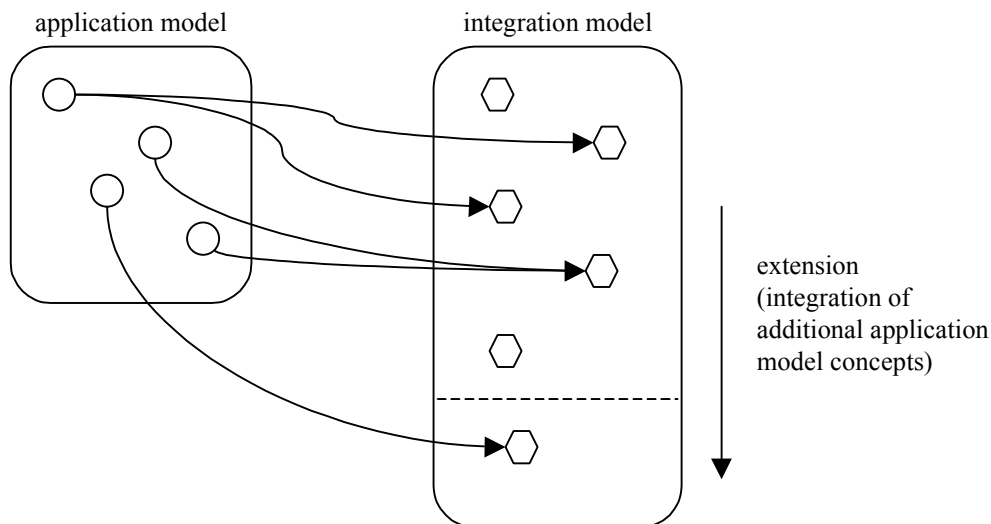


Figure 8 – Extending the integration model

The method applied to extending an integration model may depend on the following:

- the structure and semantics of the existing integration model;
- the modelling paradigm and principles applied in its development and extension;
- the modelling language in which it is defined.

Subject to these dependencies, extension to an integration model may have one or more of the following characteristics. For an entity-relationship model these are:

- creation of additional classes as specializations of existing classes in the integration model;
- creation of additional reference instances within the integration model.

For a logic-based model these are:

- creation of additional constructs within the integration model.

Such extensions shall not modify existing classes in the integration model since to do so can invalidate existing maps between the integration model and other application models.

If it is necessary to develop a new integration model to satisfy the requirements of the application model(s) to be integrated, then a mapping specification between the original integration model and the new integration model shall be developed.

5.2.3 Post conditions

On completion of the process of defining or extending an integration model, the following post conditions shall be satisfied.

- The scope of the integration model shall completely cover the scope(s) of the application model(s) to be integrated.
- All voids in the integration model during the requirements analysis phase (see 5.1) shall be filled by extensions to the integration model.
- The semantic relationships that have been discovered between the concepts of the application model(s) and the integration model shall be documented.

NOTE It may not be possible to verify that these post conditions have been satisfied until the mapping specification(s) for the application model(s) being integrated have been created.

5.3 Identifying a subset of the integration model

The purpose of this activity is to identify the subset of the integration model that precisely corresponds to the application model. In order for maps between the integration model and multiple application models to be managed, the identification of each application model-specific subset shall form a part of the integration model. The integration environment shall therefore include capabilities that allow subset identifications to be recorded.

EXAMPLE If the integration model and application models of interest are defined in EXPRESS, the integration model subset can be represented by a SCHEMA in which the selected entity data types of the integration model are identified by USE FROM statements.

This may not be strictly necessary – especially if EXPRESS-X provides a similar capability in its VIEW and/or MAP constructs.

This activity is illustrated in Figure 9 below.

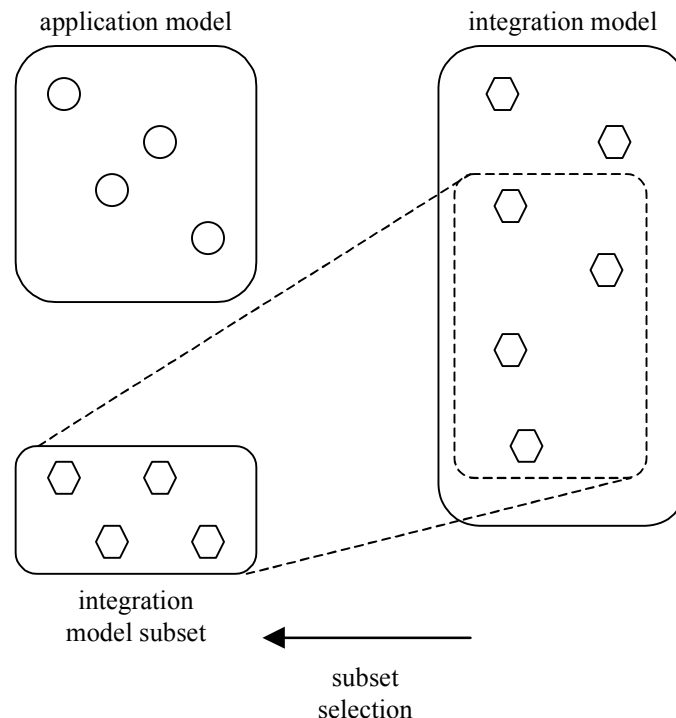


Figure 9 – Identifying a subset of the integration model

In many cases the subsetting and mapping activities are iterative, in that the extent of the integration model subset may not be fully determined until all the constructs of the application model have been mapped.

5.4 Mapping between the application model and the identified integration model subset

The purpose of this activity is to document, in an unambiguous and computer-interpretable form, all the relationships between constructs of an application model and the corresponding subset of an integration model.

5.4.1 Preconditions

5.4.1.1 Mapping languages

Mapping specifications specify the transformations that determine how the instances of one model can be represented as instances of another model. Mapping specifications are used in two ways, as follows.

The mapping specification can describe the mapping transformations between a subset of an integration model and a pre-existing application model that governs data that is separate from that governed by the integration model. In this case the mapping specification describes the transformations that enable assertions of equivalence of instances of one model to be made with respect to instances of the other.

The mapping specification can describe the mapping transformations between a subset of an integration model and an application model that is used as an application view. In this case the mapping specification describes how instances in the application view are created from instances in the integration model.

NOTE See Annex C for guidelines for the use of the EXPRESS-X language (ISO 10303-14) to specify mappings.

The following assumptions apply to the mapping specifications that are created during the integration process.

- New concepts or constraints are not introduced in the mapping specification; mapping specifications are limited to transformations of structure, terminology, and encoding.
- A complete mapping specification is bi-directional; however, the transformations from the first model to the second model may have to be specified separately from those from second model to the first model, and the mapping in one direction need not be derivable from the mapping in the other direction.

Choice of a mapping language depends on the nature of the mapping specifications to be created. A mapping can be described by several specifications each addressing only one part or stage of the mapping; different mapping languages can be used for these different parts of the overall mapping specification.

NOTE Inappropriate choice of mapping language can lead to limitations on the models that can be mapped

Mapping languages should provide the following capabilities:

- specifying mappings based on data types;

NOTE 1 A mapping specification that relates one data type to another is a shorthand for stating that each instance of one data type is mapped to a corresponding instance of another data type.

- specifying mappings from one data type to another data type, specifying mappings from one data type to a combination of data types, specifying mappings from a combination of data types to one data type, and specifying mappings from one combination of data types to another;

NOTE 2 Mapping specifications that involve a combination of data types often require a query statement or expression to define the extent of instances for which the mapping is valid.

- identifying collections of instances for which a mapping is specified;

NOTE 3 Collections of instances can be specified based on data types, attribute values or value ranges, relationships, reference paths, or any combination of these.

- specifying mappings that associate a data type in one application model with a specified instance or collection of instances in another application model;

EXAMPLE 1 An entity data type **pump** in an application model may map to an instance of a more general entity data type **class_of_physical_object** in an integration model, where the name of the instance is constrained to be 'pump'.

- specifying transformations between data values;

EXAMPLE 2 An entity data type **person** with a single-valued attribute **name** may map to an entity data type with two attributes **first_name** and **last_name**. The transformation from the second model to the first is concatenation of attribute values; the transformation in the other direction requires parsing of the source attribute value.

EXAMPLE 3 Different models may use different units of measure for representation of physical quantities such as length or mass.

- specification of mappings that are based on repeated patterns that may be parameterized.

EXAMPLE 4 In EXAMPLE 1 above, the association of a name with a class in the integration model may involve related instances of several different entity data types. By identifying this combination as a template for other mappings, the mapping specification can be simplified and made more consistent.

- definition of variables within the name space of each model that is part of the mapping.

5.4.2 Method description

The activities of analysis (see 5.1) and subsetting (see 5.2.3) establish a data specification (an integration model subset) that is semantically equivalent to the application model. This integration model subset will, however, in the general case differ from the application model in its structure and/or its terminology. The mapping activity therefore establishes and describes the transformations that are applied to data that conforms to the integration model subset such that it conforms to each of the application models (and vice versa). The mapping activity is illustrated in Figure 10 below.

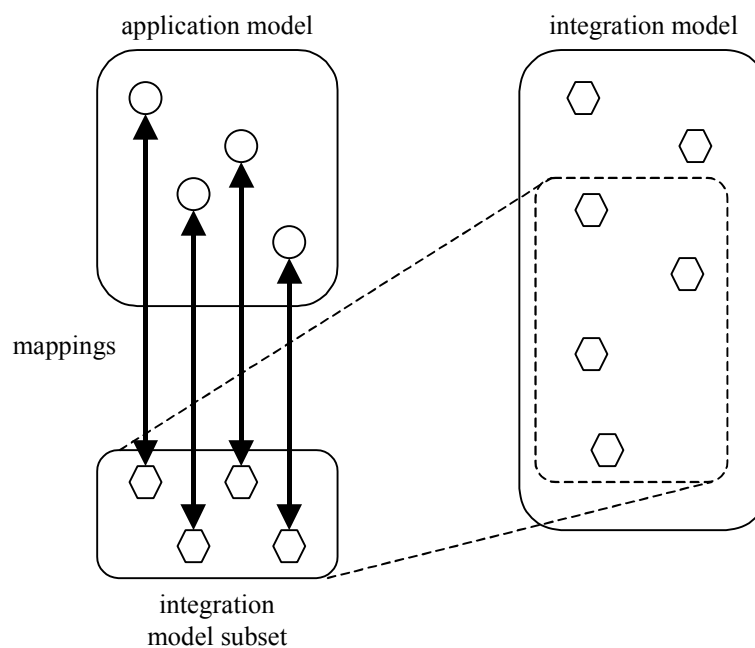


Figure 10 – Mapping between the application model and the integration model subset

The result of this activity is a mapping that characterizes the following:

- the correspondence of each construct in the application model with constructs in the identified subset in the integration model subset;
- the correspondence of each construct in the integration model subset with constructs in the identified subset in the application model.

The following constraints apply to these components of the mapping:

- every construct in the application model shall have a defined correspondence with one or more constructs of the integration model subset;
- every constraint in the application model shall have a defined correspondence with one or constraints in the integration model or in the mapping.

The mapping between the integration model and each application model that is integrated with it shall be recorded as part of the integration environment.

5.4.3 Post conditions

The overall activity of integrating an application model is complete when the following specifications have been completed and validated:

- the subset of the integration model that precisely corresponds to the semantics of the application model;
- the mapping that defines the transformations between the application model and the identified integration model subset.

6 Conformance

This section will define conformance requirements with respect to:

integration models – referencing the preconditions documented in 5.2

integrated data models (i.e., an application model with a defined/documented map to an integration model).

A key test for this document is whether such conformance requirements can actually be documented and, if so, whether there is value to applying them. My assumption at this time is that any conformance requirements documented here will be “abstract” in nature serve as the basis for defining “real” conformance statements in other standards. For example, a standard integration model can define conformance requirements on its extensions, or for the maps to be defined when application models are integrated to/with it.

Annex A

(normative)

Information object registration

To provide for unambiguous identification of an information object in an open system, the object identifier

`{iso standard 18876 part{2} version {1}}`

is assigned to this part of ISO 18876. The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

NOTE This is the object identifier that will apply to the published (IS) version of this part of ISO 18876.

The reference to Part 1 of STEP assumes that the second edition of Part 1 defines usage of ASN.1 identifiers that is not limited to ISO 10303.

Annex B (normative)

Description of the integration process

This annex describes the integration process using an activity model. The activity model uses the IDEF0 technique [1] and is presented as a set of figures that contain the activity diagrams and a set of definitions of the activities and the flows between them.

NOTE For ease of presentation the abbreviations AM and IM are used in these IDEF0 diagrams to stand for application model and integration model respectively.

B.1 Integrate application models (A-0)

The context diagram for this description of the integration process is shown in Figure B-1.

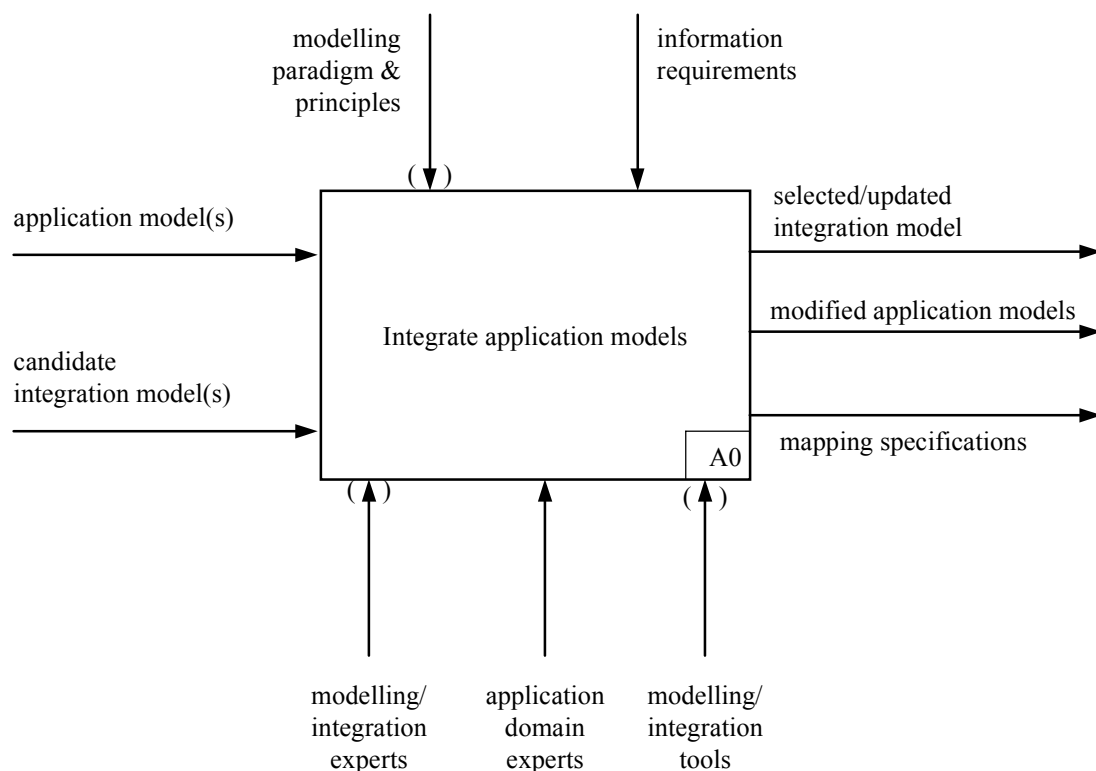


Figure B-1 – Integrate application model (A-0)

The activity and flows shown in Figure B-1 are defined as follows.

B.1.1 Application domain experts

people with knowledge of the processes and information supported by an application model (mechanism)

B.1.2 Application model(s)

see 3.1 (input)

B.1.3 Candidate integration model(s)

integration model(s) whose model context covers that of the application model(s) to be integrated (input)

B.1.4 Information requirements

models, documents, sample data, diagrams, and other descriptions of the information used within a specific application domain (control)

B.1.5 Integrate application models

apply the methods specified in this part of ISO 18876 in order to represent the concepts, structure, terminology, and constraints of an application model in terms of an integration model (A0)

B.1.6 Mapping specification

see 3.15 (output)

B.1.7 Modelling paradigm and principles

rules, guidelines, and practices that apply to the integration and modelling activities (control)

B.1.8 Modelling/integration experts

people with knowledge and experience of developing and using integration models and creating mapping specifications between application models and integration model (mechanism)

B.1.9 Modelling/integration tools

software and other tools used to create, validate, and publish models, mapping specifications, and other specifications (mechanism)

B.1.10 Modified application model

revised representation of the information used within a specific application domain (output)

NOTE Some scenarios preclude modification of the application model. For example, if the application model is in use by one or more application systems then it may be inappropriate to change it in the integration process.

B.1.11 Selected/updated integration model

integration model that has been selected as suitable to integrate one or more application models; the integration model may be extended as part of the integration process (output)

B.2 Integrate application model (A0)

The decomposition of this activity is shown in Figure B-2.

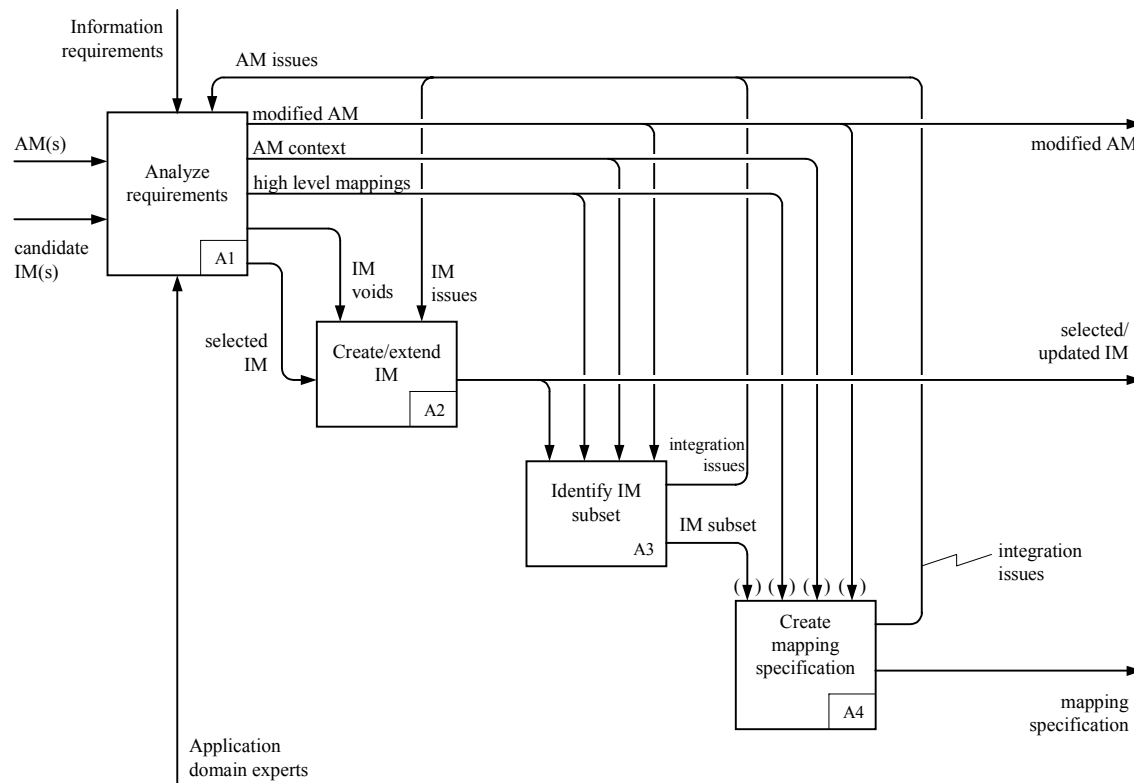


Figure B-2 – Integrate application model (A0)

B.2.1 Analyze requirements

review the application model and/or other sources of information about the requirements of one or more application domains in order to select or create a suitable integration model that covers the required model context and model scope (A1)

B.2.2 Application domain experts

see B.1.1 (mechanism for A1)

B.2.3 Application model context

the model context (see 3.17) of an application model (output from A1; control on A3 and A4)

B.2.4 Application model(s)

see 3.1 (input to A1)

B.2.5 Candidate integration model(s)

see B.1.3 (input to A1)

B.2.6 Create/extend integration model

develop an integration model that covers the scope and context of the application model(s) to be integrated, or extend an existing integration model to meet these requirements (A2)

B.2.7 High level mappings

initial mappings of concepts in the application model(s) and concepts in the integration model (output from A1, control on A2 and A3)

B.2.8 Identify integration model subset

select the constructs of the integration model that satisfy the concepts and constraints of the application model (A3)

B.2.9 Information requirements

see B.1.4 (control on A1)

B.2.10 Integration issues

issues against the integration model resulting from the integration and mapping processes (output from A3 and A4; control on A2)

B.2.11 Integration model voids

concepts that are present in an application model but are missing from an integration model with which the application model is to be integrated (output from A1, control on A2)

B.2.12 Create mapping specification

define how instances of each model are mapped to instances of the other (A4)

B.2.13 Mapping specification

see 3.15 (output from A4)

B.2.14 Modified application model

see B.1.10 (output from A1, control on A3 and A4)

B.2.15 Selected integration model

integration model that has been chosen in order to integrate one or more application models, or is capable of extension to do so (output from A1, input to A2)

B.2.16 Selected/updated integration model

see B.1.10 (output from A2, control on A3)

B.3 Analyze requirements (A1)

The decomposition of this activity is shown in Figure B-3.

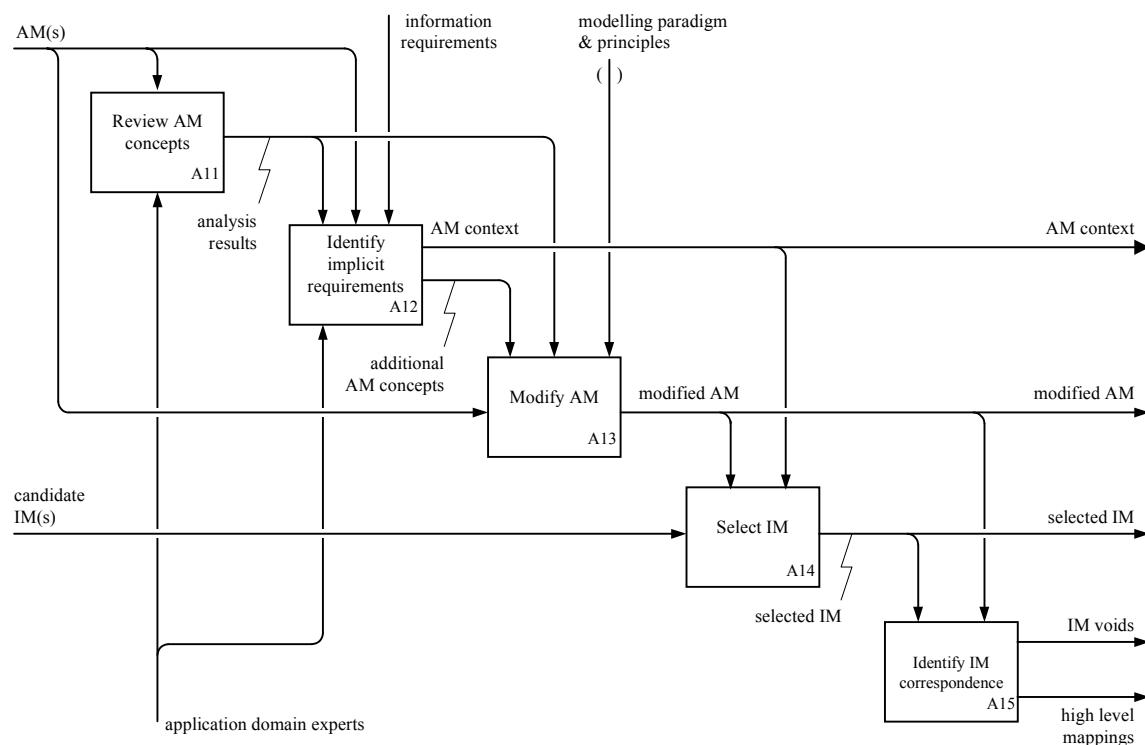


Figure B-3 – Analyze requirements (A1)

B.3.1 Additional application model concepts

concepts within the scope and context of the application model that are discovered by analysis of the existing application model and additional information requirements (output from A12, control on A13)

B.3.2 Analysis results

understanding of the concepts represented by the application model based on knowledge of other application models and existing integration models (output from A11, control on A12 and A13)

B.3.3 Application domain experts

see B.1.1 (mechanism for A11 and A12)

B.3.4 Application model context

see B.2.3 (output from A12, control on A14)

B.3.5 Application model(s)

see B.1.2 (input to A11)

B.3.6 Candidate integration model(s)

see B.1.3 (input to A14)

B.3.7 High level mappings

see B.2.7 (output from A15)

B.3.8 Identify implicit requirements

discover and document requirements within the scope and context of the application model that are not explicitly represented by the constructs of the application model (A12)

B.3.9 Identify integration model correspondence

establish the high level mappings between the concepts of the application model and those of the selected integration model (A15)

B.3.10 Information requirements

see B.1.4 (control on A12)

B.3.11 Integration model voids

see B.2.11 (output from A15)

B.3.12 Modelling paradigm and principles

see **Error! Reference source not found.** (control on A13)

B.3.13 Modify application model

revise the structure and content of the application model in order to increase its quality and consistency (A13)

B.3.14 Review application model concepts

assess the concepts represented by the application model in order to fully understand the problem domain for the integration process (A11)

B.3.15 Select integration model

identify an integration model whose model context covers that of the application model(s) to be integrated (A14)

NOTE In order to ensure reusability of integration models, this activity should consider a wider context than just that defined by the application model(s) to be integrated.

B.3.16 Selected integration model

see B.2.14 (output from A14, control on A15)

B.3.17 Modified application model

see B.1.10 (output from A13, control on A14 and A15)

B.4 Create/extend integration model (A2)

The decomposition of this activity is shown in Figure B-4.

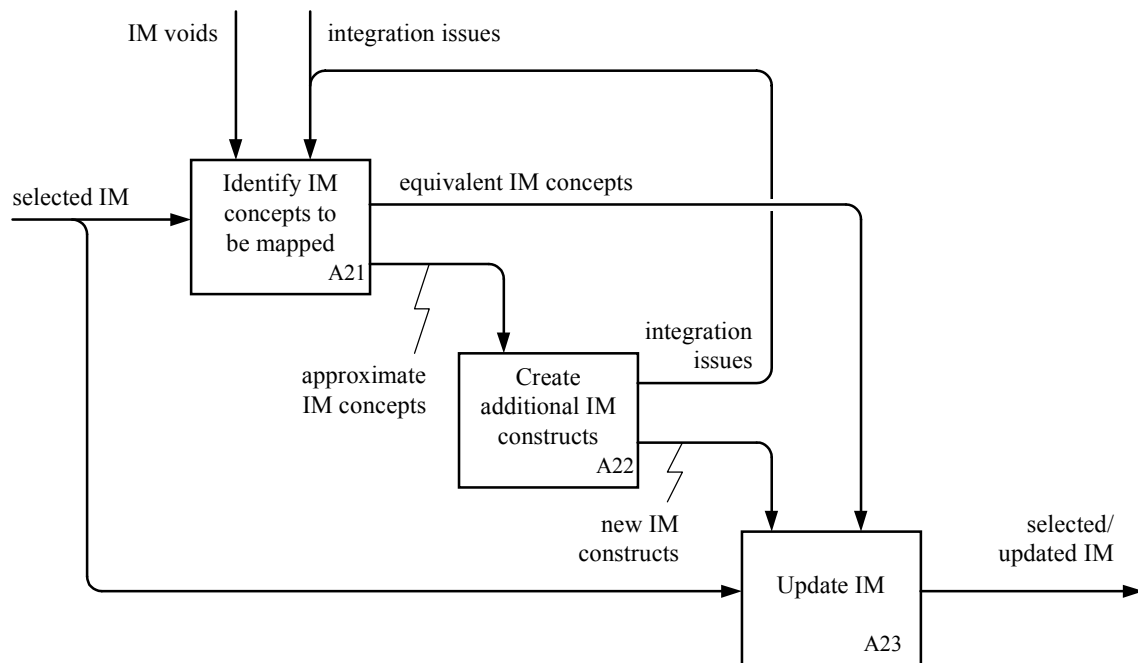


Figure B-4 – Create/extend integration model (A2)

B.4.1 Approximate integration model concepts

concepts that are represented by constructs of the selected integration model whose meaning corresponds to, but is not identical to, the voids identified (output from A21, control on A22)

EXAMPLE An integration model construct that represents a generalization of a concept required by a specific application model is an approximate integration model concept

B.4.2 Create additional integration model constructs

develop new constructs that extend the integration model to fill the identified voids (A22)

B.4.3 Equivalent integration model concepts

existing integration model concepts whose meaning and constraints precisely match those previously identified as voids (output from A21, control on A23)

NOTE Such equivalence may be discovered as a result of resolving differences in model representation or terminology.

B.4.4 Identify integration model concepts to be mapped

discover integration model concepts whose meaning and constraints cover those of the identified voids (A21)

B.4.5 Integration issues

see B.2.10 (control on A21, output from A23)

B.4.6 Integration model voids

see B.2.11 (control on A21)

B.4.7 New integration model constructs

extensions to the integration model (output from A23, control on A24)

B.4.8 Selected integration model

see B.2.14 (input to A21 and A24)

B.4.9 Selected/updated integration model

see B.1.10 (output from A24)

B.4.10 Update integration model

revise the definitions, diagrams, and other specifications that describe the integration model following appropriate documentation and quality methods

B.5 Map application model to integration model subset (A4)

The decomposition of this activity is shown in Figure B-5.

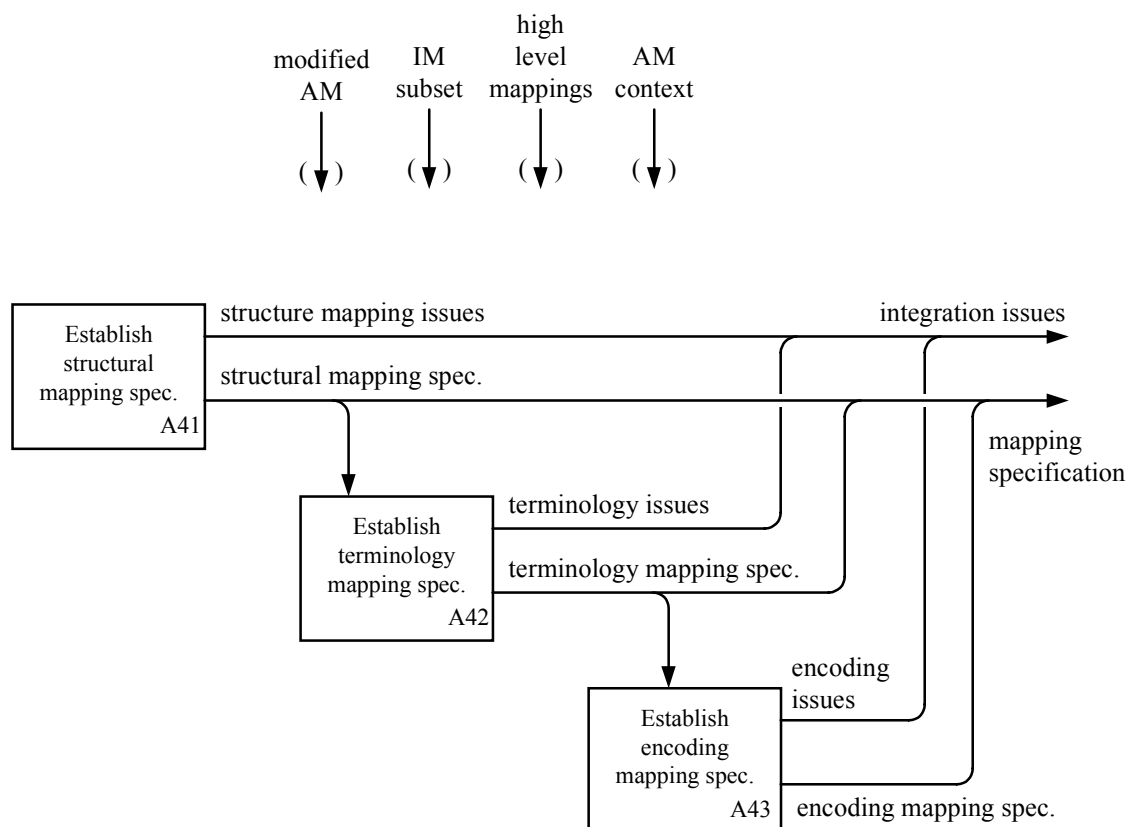


Figure B-5 – Map application model to integration model subset (A4)

B.5.1 Encoding issues

integration issues arising from the assessment of encoding transformations (output from A43)

B.5.2 Encoding mapping specification

mappings specification between the encodings of the application model and those of the integration model subset (output from A43)

B.5.3 Establish encoding mapping specification

identify mapping specification between the encodings of the application model and those of the integration model subset (A43)

B.5.4 Establish structural mapping specification

identify mapping specifications between the structure of the application model and that of the integration model subset (A41)

B.5.5 Establish terminology mapping specification

identify mapping specifications between the terminology of the application model and that of the integration model subset (A42)

B.5.6 Integration issues

see B.2.10 (output from A41, A42, and A43)

B.5.7 Mapping specification

see B.1.6 (output from A41, A42, and A43)

B.5.8 Structural mapping specification

mapping specifications between the structure of the application model and that of the integration model subset (output from A41)

B.5.9 Structure mapping issues

integration issues arising from the assessment of structural transformations (output from A41)

B.5.10 Terminology issues

integration issues arising from the assessment of terminology transformations (output from A42)

B.5.11 Terminology mapping specification

mapping specifications between the terminology of the application model and that of the integration model subset (output from A42)

Annex C (informative)

Guidelines for integration and mapping using EXPRESS (ISO 10303-11) and EXPRESS-X (ISO 10303-14)

To be added

Annex D (informative)

Technical discussions

D.1 Models, data, and data models

Discussion of models (including data models) needs to differentiate between the contents of the model and what the model represents. In the case of physical models this is clear: there is no problem in distinguishing a 1:100 plastic model of the Eiffel Tower from the actual Eiffel Tower in Paris. There are clear differences in the characteristics of the model and what it represents.

In the case of data models, however, this distinction may be less clear since the model and its subject share many characteristics. Figure D-1 illustrates the relationships between a data model and its subject.

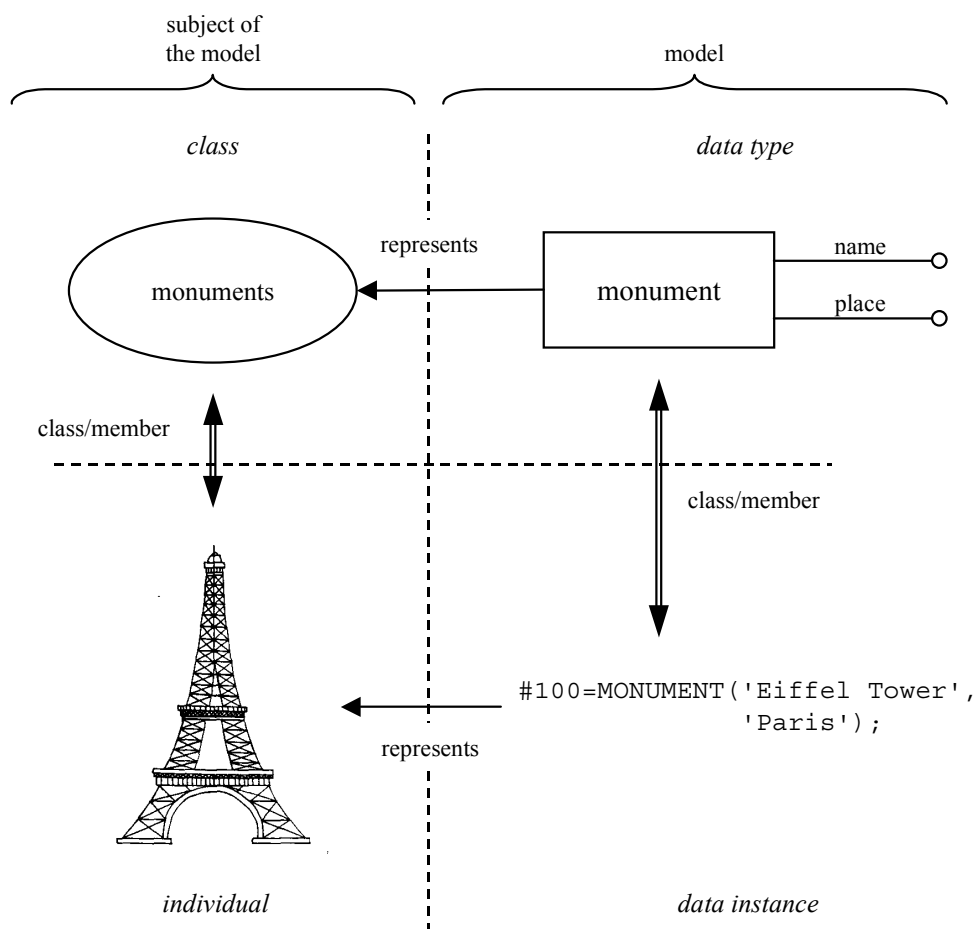


Figure D-1 – Relationship between a model and its subject

Figure D-1 illustrates a very simple data model whose subject is monuments. The objects of interest for this model (i.e., its model scope or universe of discourse) are individual things such as the Eiffel Tower, the Empire

State Building, the Pyramids of Giza, and Albert Memorial that are members of class called “monuments”⁴. The model consists of a declaration of a data type in the EXPRESS language (ISO 10303-11); the identifier of this data type is **monument**. This entity data type represents or stands for the class called “monument”, and allows computer systems to store or interchange information (as data values) about monuments. In this case, the information of interest is represented by the attributes of the data type, i.e., the name of the monument and its location.

As well as representing the class “monument”, the entity data type **monument** is itself a class, whose members are data values or instances that conform to the structure defined by the entity data type declaration. Instances of data types defined in EXPRESS can be encoded according to ISO 10303-21 – the sequence of characters introduced by #100 in Figure D-1 is such an encoded instance. This is both a member of class defined by the data type monument (the data structure conforms to that declared in the entity data type and the data values conform to the data types and constraints declared for its attributes), and also represents an individual (the Eiffel Tower) that is a member of the class “monument” represented by its data type. This second link can in part be inferred the following statements:

- #100 is a member of the class defined by **monument** (instance of the data type);
- the data type **monument** represents or stands for the class “monument”;
- the Eiffel Tower is a member of the class “monument”.

The last part of the link, that #100 represents the Eiffel Tower, and not some other member of the class “monument”, depends on the ability of an interpreter of the data values (human or computer) to relate the character sequences ‘Eiffel Tower’ and ‘Paris’ to the actual structure in the capital city of France.

NOTE In the situation illustrated by Figure D-1, data values/instances can also represent classes if the data model contains data types that represent classes whose members are themselves classes. For example, an EXPRESS entity data type **class** can be defined to represent the class whose members are (all) other classes. If the data type is declared as follows:

```
ENTITY class;
  name : STRING;
END_ENTITY;
```

then an instance encoded as:

```
#101=CLASS( 'monument' );
```

represents a class called “monument” – possibly the same class as represented by the entity data type **monument** in the model fragment shown in Figure D-1.

In this International Standard, the term “concept” is used to refer to classes and other ideas that are the subjects of (data) models; the term “construct” is used to refer to elements of (data) models that stand for or represent concepts.

D.2 Integration and mapping methodology

*** text moved here (was a clause outline in the previous draft) to make sure that the points listed here are covered elsewhere in the document ***

In the original outline for this part this section (actually two sections, one titled “Integration method”, the other “Mapping method”, was intended to be the core of the specification and to contain all the details of the operation of the methodology. However, as the “overview” in clause 4 has grown considerably larger and more detailed than I originally envisaged, it is

⁴ The following typographical convention is used in this Annex: names of classes are enclosed in quotation marks “...”; names of data types are set in **bold font**.

difficult at this time to see what additional detail could be given here that is both normative and independent of language/models.

Going back to the table of contents for Part 2 that was presented at the Melbourne meeting, we said that this part would cover several elements that probably end up as additional informative annexes. The pieces that we listed were:

Procedures (“what to do”) – as far as is possible without dealing in the specific procedures associated with a given integration model, clause 4.2 goes a long way towards satisfying this requirement.

Practices – analysis (“how to do it”) – again, 4.2 discusses this at a level of detail that is appropriate in an integration model-independent specification. However, if we follow the statements in clause 5.2 that lead (deliberately!) to the conclusion that EPISTLE-style models are well suited to act as integration models, then we ought to be able to adapt parts of Developing High Quality Data Models as an informative annex on analysis practices.

Practices – languages and tools. Having established some preconditions for modelling and mapping languages in 5.3.1 and 5.3.2 there may not be much else to say here, unless we feel that it would be useful to provide some kind of simple “best practice guide” for some languages. Personally I think that this would be inappropriate here; such practices would have to be documented for an integration model defined in a given language.

Guidelines (“what’s the best way to do this”) – these were always intended to be outside the scope of the standard. Clearly one possible target is SC4 standing documents, although the drawback here is that all current standing documents are directed inward and really apply to SC4’s own work. An alternative might be for some industrially-based body (EPISTLE, PDES Inc., ...) to develop and publish Guidelines for use of a particular integration model and, if there is a requirement this to have an ISO “label” of some kind, to submit it as a PAS.

*** this text moved from the second on IM preconditions

I see this subclause as being a rewrite of the existing “high quality data models” material – the six principles. We may need to extend and or qualify this if we are making the methodology sufficiently general to cover the “integrate two application models” scenario (Figure 1 above), where its possible that not all the principles will apply. I know that we *can* argue for every integration model having a wide/universal context for reasons of reusability, integration, interoperability, etc. The question is whether we *should* require this approach within ISO 18876. This is the intent of the “modelling paradigm and principles” component of the diagrams above, and we can use an example to illustrate whatever choice we make here. If I have two application model fragments:

ENTITY part;	ENTITY component;
part_name : STRING;	name : label;
END_ENTITY;	alternate_name : label;
	END_ENTITY;

and analysis determines that **part** and **component** are really the same thing (probably **class_of_physical_object** and/or **physical_object** in EPISTLE terms), does the integration model that we only generalize application model1 and application model2 (two names, one being designated as “alternate” and being optional), or do we apply knowledge of the wider requirements for naming and allow for 0:? names with a specified role for each?

This is going to be a key issue especially if we hope that STEP will pick on IIDEAS as part of its evolution towards a future release of ISO 10303 based on new and improved IRs.

Annex E (informative)

Worked examples

This may be a large component of the document. Several proposals have been made for the basis of such examples:

- integrating AP203 and AP210 (possibly in the area dealing with product structure)
- integrating AP232 and the PDM schema/modules
- defining application views onto ISO 15926-2, using the EPISTLE work on “templates” as a starting point
- integrating PLIB’s dictionary schema with ISO 15926-2
- integrating two XML DTDs with overlap in their scope/subject area

Only the last of these really goes outside the SC4/EXPRESS modelling domain – we probably need to identify some examples from outside – one possibility that comes to mind is to take the IAI’s geometry model (which uses EXPRESS but assumes a default ONE OF and, although based on Part 42 of STEP is different from it), and the UML geometry model produced by TC211 in the GIS domain.

Another possibility might be something from the EDIF area – possibly Hilary Kahn and/or Robin La Fontaine could supply something here based on the work of the STEPWISE project.

For the initial drafts at least the number of examples to be included will have to be restricted. A possible way forward is for this Annex to do nothing more than provide a URL to a webpage where worked examples can be published (presumably on the www.iso18876.org website).

A number of worked examples that illustrate the methodology defined by this part of ISO 18876 are available from the Internet:

`<http://www.iso18876.org/examples/>`

Annex F

(informative)

Issues log

This annex lists issues raised against previous drafts of this document.

Issues to be incorporated from the minutes of the Winter Park and Charleston meetings – if people start to use the iso18876@egroups.com facility, then the task of managing issues will become easier!
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Bibliography

1. ISO/TR 9007:1988, *Information processing systems -- concepts and terminology for the conceptual schema and the information base*.
2. ISO 10303-21:1994, *Industrial automation systems and integration – Product data representation and exchange – Clear text encoding of the exchange structure*.
3. ISO/IEC 14481:—⁵⁾, *Information technology (IT) — Conceptual schema modelling facilities (CSMF)*
4. IEEE Std 1320.1-1998, *Standard for Functional Modeling Language – Syntax and Semantics for IDEF0*.
5. BARWISE, Jon; SELIGMAN, Jerry. *Information flow: the logic of distributed systems*. Cambridge: Cambridge University Press, 1997.
6. DANNER, William F.; YANG, Yuhwei. *STEP (Standard for the Exchange of Product Model Data) Development Methods: Specification of Semantics for Information Sharing*. ISO TC184/SC4/WG5 N30, 1992-01-25
7. FOWLER, Julian, *Industry requirements for SC4 standards*, ISO TC184/SC4/WG10 N173, 1998.
8. FULTON, James. *Semantic plug and play*.
9. GUARINO, Nicola. *Some Organizing Principles for a Unified Top Level Ontology*. Padua: 1997, available from the Internet: <<http://www.labseb.pd.cnr.it/infor/ontology/ontology.html>>
10. GUARINO, Nicola. *Some Ontological Principles for Designing Upper Level Lexical Resources*. Padua: 1998, available from the Internet: <<http://www.labseb.pd.cnr.it/infor/ontology/ontology.html>>
11. PARTRIDGE, Chris. *Business objects: re-engineering for reuse*. Oxford: Butterworth Heinemann, 1996.
12. SOWA, John F. *Knowledge representation: logical, philosophical, and computational foundations*. Pacific Grove CA: Brooks/Cole, 2000.
13. WEST, Matthew; FOWLER, Julian. *Developing High Quality Data Models*. Version 2.0, Issue 2.1. EPISTLE, 1996. Available from the Internet: <<http://www.stepcom.ncl.ac.uk>>
14. *EPISTLE Core Model, V3.1*. September 1999. Available from the Internet: <<http://www.posccaesar.org/prodserv/epistle3.1/epistle.htm>>

⁵⁾ To be published.

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